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Soil Survey

of

Marion County, Kansas

By

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United States Department of Agriculture, In Charge
and
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Kansas Agricultural Experiment Station

Bureau of Chemistry and Soils

In cooperation with the Kansas Agricultural Experiment Station

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SOIL SURVEY OF MARION COUNTY, KANSAS

By E. W. KNOBEL, United States Department of Agriculture, in Charge, and R. O. LEWIS, Kansas Agricultural Experiment Station

COUNTY SURVEYED

Marion County is in the east-central part of Kansas, about 75 miles north of the Oklahoma State line, and Marion, the county seat, is about 50 miles slightly northeast of Wichita (fig. 1). The county includes an area of 953 square miles, or 609,920 acres.

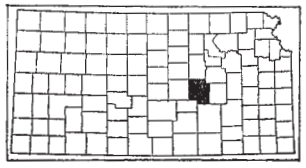

FIGURE 1.—Sketch map showing location of Marion County, Kans.

The topographic features of the greater part of the county—approximately three-fourths—are gently undulating or slightly rolling. All that part west of a line running northwestward from a point several miles east of the middle of the southern boundary to the central part of the county and thence northeastward to the eastern county line near the headwaters of Middle Creek has smooth relief, except a small area in the northwestern corner where it is rough. Within this broad belt the western part is somewhat more sharply dissected than the northeastern, but practically none of its area is too rough for cultivation.

In the southwestern part of the county the surface relief is flat. Therefore drainage is more or less imperfect, as indicated on the soil map by the total lack of drainageways. This almost flat prairie occurs at a comparatively higher level than other parts of the county, approximately 1,550 feet above sea level, and includes (in Marion County) only a 3-mile strip terminating 12 miles north of the southwestern corner but continuing west through McPherson County.

In the northwestern part of the county the surface relief in a narrow oval-shaped belt of land along the north county line, ranging from 1 to 2 miles in width and about 10 miles in length, is somewhat rough, owing to dissection by a number of ravines which have worked headward and southward into the comparatively high plain of Marion County from a lower plain north of the county boundary. This area is underlain by sandstone, giving rise to a somewhat sandy soil which erodes easily.

The surface features are more varied in the east, east-central, and southeastern parts of the county. This section lies partly within the somewhat hilly region known as the Flint Hills. It is a belt of country stretching across the State from north to south, underlain by beds of limestones and shales, some of the former being indurated. That part of the belt included in Marion County is dissected rather thoroughly by Cottonwood River and its many tributaries. In places the depth of local dissection is somewhat more than 300

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feet. Irregular-shaped rims of steep rocky limestone land, ranging from a rod or so to more than a half mile in width, mark the sharply dissected slopes and deep intervening ravines of the crooked streams. The eastern tier of townships is also marked in many places by a secondary or lower rim of like material, with intervening moderately sloping stone-free areas, and in a few places by a third rim of rocky material. These irregular limestone belts or rims are broadest near the county line, and gradually diminish in width in the central and north-central parts. Above the higher limestone rims are numerous flat or gently undulating stone-free ridge-top belts.

Elevations above sea level of the different towns along the railroads are as follows: Florence, 1,269 feet; Marion, 1,310 feet; Peabody, 1,349 feet; Durham, 1,378 feet; Aulne, 1,404 feet; Lincolnville, 1,432 feet; Ramona, 1,436 feet; Tampa, 1,438 feet; Lost Springs, 1,476 feet; Burns, 1,488 feet; and Hillsboro, 1,424 feet. These elevations show a difference of 219 feet between the lowest and highest.

The alluvial belts along the streams are comparatively narrow in most places, but in the east-central part of the county the main valley of Cottonwood River is wider than elsewhere.

The county is treeless, except in places where narrow fringes of trees grow along the banks of the larger stream channels and in a few of the sharper bends. The fringes of timber gradually thin out upstream, until, within a mile or so of the source of the smaller drainageways, only a few scattered trees are present. In the northwestern part, where the land is underlain mainly by sandy material, trees are very scarce. Elm, oak, cottonwood, ash, boxelder, willow, sycamore, walnut, and locust constitute the principal timber growth. Transplanted trees for shade or windbreaks, mainly elm, cottonwood, catalpa, and maple, are common about the farm homes, as well as in all the towns. In their virgin condition the smooth areas were covered with a luxuriant growth of prairie grasses.

In 1930 the population of Marion County was 20,739, which places it twenty-seventh in rank among the counties of the State. The average density is 21.8 persons a square mile. All towns with less than 2,500 population are classed as rural. Eliminating 8,475 people who live in the several towns and villages, the number actually living on farms is about 12,264, or 12.9 persons to the square mile. In 1930, Marion, the county seat, had a population of 1,959; Florence, 1,493; Hillsboro, 1,458; and Peabody, 1,491. Burns, Lehigh, Durham, Tampa, Lincolnville, Lost Springs, and Ramona are smaller towns. The population is well distributed, except in the eastern, southeastern, and the extreme northwestern parts, where a large proportion of the land is nonarable. Most of the residents of Durham and Lehigh are German Mennonites, and the northern and western parts of the county are occupied largely by people of German descent. Marion County was organized in 1865.

There are several oil fields, of which the Peabody and Florence fields are the most important. There are about 200 producing oil wells, all of which are operated by pumps. The fields mentioned are on the decline, having been under production for more than 12 years.

Adequate transportation facilities by rail are furnished by the Atchison, Topeka & Santa Fe Railway and the Chicago, Rock Island & Pacific Railway. Most farmers live within 6 or 8 miles of a railroad, and comparatively few are more than 10 miles distant. United States Highway 50–N., United States Highway 77, and a State highway, K–15, are well graded and surfaced with concrete or gravel. The county roads are well maintained, but most of them are not hard surfaced. Ordinarily they follow section lines. However, in some of the rougher areas, there are no roads throughout several sections combined. Bridges are adequate and in good condition. Chicago, Kansas City, Omaha, St. Louis, and Wichita constitute the principal markets. The exports consist chiefly of livestock and small grain.

Telephone and rural delivery of mail serve practically all parts of the county. There are more than a hundred schools, several of which are consolidated. A Mennonite college for girls (Tabor College), with a full curriculum, is located at Hillsboro. There are also several very fine churches.

Good water, in sufficient quantity for domestic and other uses, is easily obtained, and supplies of water for livestock in the grazing sections are obtained in many places by building small dams across drainageways. Some of the well water is hard, but water obtained from the larger springs, such as those supplying the town of Florence, is of excellent quality.

CLIMATE

The climate of Marion County is temperate and is characterized by moderate summers and winters, although wide seasonal variations prevail over a period of years. About 70 percent of the average annual rainfall of 31.31 inches falls during the growing season, from April to September, inclusive. Serious injury to the staple crops or livestock, caused by extremes in climatic conditions, is rare. Ordinarily the winters are comparatively mild, but occasionally a cold wave, accompanied by high north winds, may reduce the temperature well below zero. Either gentle snowfall or severe drifting may occur in some years, whereas in others the ground may remain bare practically all winter. Low temperatures, owing to the dryness of the air, are somewhat less penetrating than in the eastern part of the State.

The spring and fall months are cool but windy, and they may be either very dry or extremely wet. As a rule, the autumn weather is pleasant. The summers are hot, with high winds from the south and southwest, attaining the highest velocity during the warmer part of the day and receding in the evening and night. High winds during June occasionally severely injure the wheat, and later in the season may sometimes materially damage the corn and kafir crop. In general, the amount of rainfall is the limiting factor in crop production. Occasionally high winds cause severe dust storms which cause more or less injury to small grains, especially if the soils contain a high proportion of fine sand or very fine sand and the plants are still young. Periods of drought during July and August, which are highly injurious to the corn crop, are rather common. Hailstorms sometimes occur, but they are local to small areas only.

Damage to field crops from early and late frosts is rare. The average date of the last killing frost at Marion is April 18, and that of the first is October 14, giving an average frost-free season of 179 days. The latest frost on record is May 20 and the earliest, September 20.

Table 1, compiled from records of the United States Weather Bureau station at Marion, gives the normal monthly, seasonal, and annual temperature and precipitation, which are representative of conditions over most of the county.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Marion, Marion County, Kans.*

[Elevation, 1,310 feet]

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1921)	Total amount for the wettest year (1915)
	°F.	°F.	°F.	Inches	Inches	Inches
December	32.1	73	−8	1.08	0.40	0.50
January	30.8	73	−20	.66	1.19	1.72
February	30.1	82	−29	1.30	(1)	4.31
Winter	31.0	82	−29	3.04	1.59	6.53
March	44.2	92	−7	1.88	1.95	2.36
April	56.6	97	11	3.40	3.69	4.90
May	64.7	103	26	4.15	1.98	6.82
Spring	55.2	103	−7	9.43	7.62	14.08
June	73.9	108	40	4.36	5.18	4.10
July	78.7	111	48	3.07	.51	5.82
August	78.7	108	43	3.84	3.62	5.34
Summer	77.1	111	40	11.27	9.31	15.26
September	69.5	105	28	3.20	2.63	2.91
October	57.7	97	15	2.49	1.14	3.33
November	48.0	86	0	1.88	(1)	.60
Fall	58.4	105	0	7.57	3.77	6.84
Year	55.5	111	−29	31.31	22.29	42.71

(1) Trace.

AGRICULTURAL HISTORY AND STATISTICS

The agriculture of Marion County has undergone several changes since its beginning. In the sixties and seventies, some flax, hemp, tobacco, castor beans, and millet were grown, but these crops never attained much importance and by 1900 were seldom seen. No clover, timothy, alfalfa, or bluegrass were grown in the early days. By 1890, orchard fruits were common. Among the early crops grown, corn was the most important, oats being second in point of acreage. Wheat was a crop of minor importance prior to the introduction of hard winter wheat in the early seventies. The immediate success of this crop caused wheat to rapidly increase in importance. Corn, however, ranked first in acreage and production until about 1919, and since that time wheat has held first rank. In 1889, according to the United States census reports, there were 55,361 apple and 86,003 peach trees, and by 1899 there were 155,856 apple and 44,056 peach

trees. In 1929, however, the number of apple trees had decreased to 8,121, and of peach trees, to 8,759. This decline was caused mainly by late spring frost hazards, prevailingly high winds, and also to the fact that most Marion County soils are not sufficiently friable or permeable in the subsoil for best development of fruit trees.

In 1899, 6,836 acres were devoted to alfalfa. This figure increased to 29,144 acres in 1919 but decreased to 14,140 acres in 1929. The decrease is largely owing to the susceptibility of the alfalfa plant to injury by insects and noxious weeds and grasses and also to plant diseases, such as bacterial wilt. Sweetclover, a promising legume for pasture and soil-improvement purposes, was sown on 420 acres in 1919 [1] and on 8,891 acres in 1930.[2] It is highly probable that the acreage of sweetclover will continue to increase.

The nonarable or strictly grazing land represents 20.8 percent of the total area of the county, whereas 195,957 acres, including arable and nonarable land, or 32.1 percent, is still utilized for grazing. One reason this percentage has remained so high is because more than 50,000 acres,[3] or about 78 square miles, is in posession of English interests and is known as "Frederick Skully land." These tracts lie chiefly in the six townships of the northwestern part, in the proximity of Tampa and Durham. The management has persisted in conserving a large proportion of the holdings for grazing purposes only. According to the 1930 Federal census report, 352,646 acres are classed as crop land, of which 341,221 acres were harvested, 7,451 acres crop failure, and 3,974 acres idle or fallow land.

The 1930 Federal census indicates that the number of farms smaller than 50 acres has increased since 1919, those ranging from 50 to 174 acres have declined, and those ranging from 175 to 1,000 or more acres have increased. The increase in the number of larger farms is explained by the fact that many of the medium-sized farms have been taken over by wealthy farmers who use power machinery for small-grain production, and the increase in the number of small farms is probably owing to the back-to-the-farm movement by people, having small incomes, unable to make a desirable living in the towns. The average size of farms is 231.4 acres. The average value of all property is $19,994 to the farm, or $86 an acre. Very little farm property has changed hands in the last few years.

In 1930, the number of farms operated by owners was 1,307, by tenants 1,147, and by managers only 6. The trend since 1900 indicates that the percentage of farms operated by owners has declined from 62.7 percent in 1900 to 53.1 percent in 1930; by tenants, has increased from 36.8 percent in 1900 to 46.6 percent in 1930; and by managers, has decreased from 0.5 percent in 1900 to 0.3 percent in 1930.

The use of power machinery has greatly increased during the last 10 years. From 1917 to about 1925, farm labor was very scarce and undependable, and harvest hands demanded high wages. The high prices obtained for wheat caused many farmers to buy expensive tractors and combines to eliminate unsatisfactory labor conditions and to

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[1] MOHLER, J. C. FARM AND CROP STATISTICS—MARION COUNTY. Kans. State Bd. Agr. Bien. Rept. (1919–20) 22: 425. 1921.

[2] MOHLER, J. C. FARM AND CROP STATISTICS—MARION COUNTY. Kans. State Bd. Agr. Bien. Rept. (1929–30) 27: 435. 1931.

[3] Taken from tax titles by W. E. Grimes, Kansas Agricultural College.

reduce the cost of small-grain production. There were 18 tractors in use in 1915, 413 in 1920, 659 in 1925, and 1,387 in 1930.[4] One combine was in use in 1923, 3 in 1926, 18 in 1928, 58 in 1929, and 124 in 1930. The prevailingly low prices of farm products, especially wheat, following 1930, will very probably cause a decline in the use of tractors and combines and necessitate an increase in the number of horses and mules.

Cattle and hogs are the more important farm animals. Horses, mainly Percherons, and mules are kept mainly as work animals, and small flocks of sheep and goats are kept for the purpose of controlling the growth of weeds and brush in pastures. Table 2 shows the trend in livestock production from 1900 to 1930.

TABLE 2.—*Numbers of several kinds of livestock in Marion County, Kans., in stated years*

Kind of animal	1900	1910	1920	1930
Horses	14,765	20,342	16,521	11,610
Mules	766	1,771	1,288	928
Cattle	74,814	63,594	27,287	51,163
Sheep	4,466	2,869	6,153	12,795
Swine	39,019	45,679	21,424	26,542

According to the 1930 census, the value of farm products in 1929 was as follows: Field crops, $1,772,911; livestock, $1,960,415; poultry and eggs sold, $319,127; wool, $17,692; honey and beeswax, $2,305; butter, cream, and whole milk sold, $532,331; and condensed milk and ice cream manufactured, $16,649.

The production of fruit and vegetables on an important scale for market has not developed because there are no large cities in or near Marion County. According to the 1926–27 biennial report of the Kansas State Horticultural Society, there were only 13 acres of land utilized for commercial gardens in 1926, with crops valued at $1,625, whereas home gardens totaled 74 acres with products valued at $9,250. Land values vary considerably, but they are more uniform than in many parts of the State.

The average farm is well improved and well equipped. Most farmsteads include a modern dwelling, a barn, a windmill, a granary, possibly a silo, and ample shade trees for the lawn. A large number of the grain farmers do not fence their land, other than that part utilized for grazing livestock. Farm machinery of various kinds is in general use, but few farmers keep their machinery under shelter.

Farm labor is mainly white. Laborers are ordinarily hired by the month, including board and are paid at the rate of $25 or $30, which is considerably less than it was 10 years ago. Harvest hands usually receive from $2.50 to $3 a day, the price depending largely on the current price of wheat.

Tables 3 and 4, compiled from United States census reports and from the reports of the Kansas State Board of Agriculture, portray the trend of crop production.

[4] These data were taken from various biennial reports of the Kansas State Board of Agriculture.

TABLE 3.—*Acreage and production of the leading crops in Marion County, Kans., in stated years*

Crop	1879		1889		1899	
	Acres	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*
Wheat	37,390	377,917	37,591	650,216	71,154	562,150
Corn	35,392	992,748	128,086	5,443,447	114,994	3,024,720
Oats	8,799	96,698	43,170	1,194,011	36,348	1,087,670
		Tons		*Tons*		*Tons*
Hay	17,487	21,595	89,172	100,898	56,279	69,920

Crop	1909		1919		1929	
	Acres	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*
Wheat	72,336	1,297,706	132,705	2,286,201	158,082	1,644,971
Corn	141,342	3,337,424	45,581	350,679	67,838	1,517,699
Oats	41,678	1,087,186	47,032	1,346,078	47,645	1,016,678
		Tons		*Tons*		*Tons*
Kafir	8,239	160,584	2,366	26,521	9,918	191,257
Hay	57,169	96,549	46,035	94,584	31,429	42,667

TABLE 4.—*Average acreage and production of the principal crops grown in Marion County, Kans., by 10-year periods*

Crop	1900–9		1910–19		1920–29	
	Acres	*Production*	*Acres*	*Production*	*Acres*	*Production*
Wheat, bushels	85,050	1,212,949	79,216	1,301,164	136,609	2,002,595
Corn, bushels	108,746	2,729,974	115,685	1,645,247	71,081	1,501,502
Oats, bushels	45,314	1,100,173	53,122	1,541,568	55,589	1,446,101
Alfalfa, tons	15,064	27,856	24,878	59,635	19,909	44,779

Figure 2 shows the percentage of cultivated land devoted to the principal crops grown, by 10-year periods.

The second period does not show an increase in wheat acreage, owing to crop failure in 1910. This caused an increase in the corn acreage, as corn could be planted after the wheat had winter-killed.

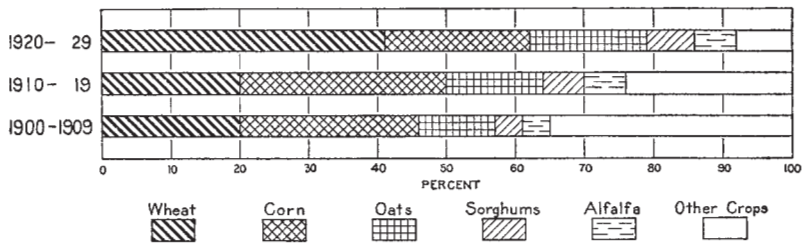

FIGURE 2.—Percentage of cultivated land devoted to the principal crops, Marion County, Kans.

Agricultural industries in any county are governed by the agricultural commodities that can be produced most advantageously and yield the greatest net profit. The crops best adapted to the soil and climate are usually grown as long as the net profit is most remunerative, but the acreage may fluctuate from year to year, depending on current prices which are regulated by supply and demand. As Marion County includes much arable and nonarable land, either

of which produces a luxuriant growth of highly succulent grasses, two dominant types of agriculture prevail—the raising and feeding of livestock and the production of grain.

The raising and feeding of livestock varies in importance with the size of the farm, the location, and the kind of feed available. Creek or river bottoms, which afford shade and water in summer and some protection in winter, are the most desirable places for raising livestock. Much of the adjoining land is rough and fit for grazing purposes only. The alluvial lands on the bottoms are adapted to the production of corn and alfalfa. Therefore both cattle and hogs are raised, but more feed is produced for cattle and sheep than for hogs, hence the raising of cattle and sheep remains the most important. The smooth upland is best suited for small grain. However, many farmers living on such land raise a few cattle and hogs for market, or own a few dairy cows.

A number of herds are grazed within the county but are not owned by resident farmers. Many fine herds of beef cattle are owned locally. However, the majority are shipped in each spring from the southern plains of Texas, Oklahoma, and New Mexico, and occasionally Brahman cattle from across the Rio Grande in Mexico. Most of the cattle are high-grade Herefords, Durhams, or Shorthorns. Some of them are shipped to terminal markets as soon as they are in good flesh and are sold as grass-fat cattle. Others may be kept on pasture if the market is unfavorable. Some seasons are so open that cattle may be wintered almost entirely on the dried pasture grasses, but some cottonseed meal and cake are usually fed. The grazing capacity of the pastures ranges from 4 to 5 acres for each animal.

The production of poultry is an important minor industry. Five percent of the cash income of the county was derived from this source in 1928. A chicken canning factory is located at Marion.

Dairying is not extensively developed, probably owing to the lack of nearby markets. Although a few fine dairy herds are kept, most of the milk cows are grades of the beef breeds. Most of the income is derived from butterfat, the demand for whole milk being local only. The value of dairy products amounted to 9 percent of the total value of farm products in 1928.

The production of wheat is the dominant industry. About 88 percent of the land area of the county being arable, small-grain production will probably remain a major industry, since it has proved a dependable crop under the existing soil and climatic conditions. On some farms it is grown to the exclusion of all other crops. The prevailing low price of wheat will, very likely, cause a shift to more livestock, which may remain permanent if the prices of livestock, poultry, or dairy products continue to give the farmer a larger return for the time, labor, and money expended. Ordinarily this practice is more advantageous, as it stabilizes his income and helps to maintain the fertility of the soil.

SOILS AND CROPS

Marion County lies in the prairie region of Kansas, the land, for the most part, consisting of a broad undulating plain. Differences in the weathered products from the various geological materials—

sandstone, limestone, and shale—have given rise to a number of soil types which differ in both chemical and physical composition. As climatic conditions are practically the same throughout the county, the soil differences would probably not be due to climatic differences but to differences in character of the underlying soil material, in the degree of development to which it has been subjected, and to the differences in drainage conditions and surface relief.

At the present stage of development, several of the soils occur in large continuous undulating areas ranging in extent from 2 to 10 or more square miles, but many soils occur mainly or entirely in one or more small areas. If the surface relief be smooth, a thick covering of clay and organic matter may be allowed to accumulate, or, on the other hand, if it be rough with steep slopes dominant, the layer of soil overlying the rock is, in most places, thin because of erosional activity.

Therefore the soils which lie on the smoother relief ordinarily are thicker, giving plant roots a wider feeding ground, and the percentage of organic matter is generally higher. The distribution of such soils determines the distribution of farms and is a factor in determining the size of farms, the kinds of crops grown, and the character of the farming system.

Under the prevailing climate, the annual average precipitation of 31.31 inches has been sufficient to remove the carbonate of calcium or limestone from the surface soil and subsoil to depths of about 3 or 3½ feet in the limestone and shale areas of mild relief where the thickness of the soil layer is that much or more, but in the soils having steep or moderately steep surface features, as erosion has almost kept pace with soil formation, the parent rock, whether that be shale, limestone, marl, or sandstone, lies near the surface, and limy material in such places lies within a few inches, in many places less than 24, of the surface. The derivation of the soils from calcareous rocks over large parts of the county, the youth of the soils, taken as a whole, and the action of the grass cover have all combined to prevent that leached condition of the soil marked by an acid condition. The reaction of the soils is mainly neutral or slightly alkaline, the structure is granular, and the consistence is friable. Good soil tilth is easily maintained.

Prior to cultivation, a luxuriant growth of prairie grasses prevailed, and through their decay, especially the roots, large quantities of organic matter, from 4 to 6 percent of the whole, accumulated in the surface soil. This has imparted a dark color to the surface soils. The high organic-matter content has several beneficial effects. It assists the soil in absorbing the sun's heat and in maintaining a uniform temperature; it greatly increases the water-holding capacity and also makes the soil more retentive of moisture, thereby insuring considerable protection against crop failure during droughts; and it materially increases the stability of the mineral soil particles and helps to maintain a desirable tilth. Furthermore the organic matter is the chief source of nitrogen which is one of the most important plant nutrients for growing crops. Continual cropping to the dominant crops is likely to diminish the supply of phosphorus, nitrogen, and organic matter, but these nutrients are generally present in sufficient quantities to produce high yields, if ample

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rainfall comes when needed. The favorable distribution of rainfall seems to be the controlling factor in obtaining maximum yields. The more sloping areas have lost large quantities of the surface soil through erosional activity.

The soils of Marion County are, however, in a far better state of preservation than those in much of the prairie region of the United States, partly because of their use in large areas for grazing. Grain growing tends to exhaust fertility rapidly, but crop rotation with either grass or legumes as an important crop in the rotation reduces greatly the rate of exhaustion.

On the basis of their agricultural utilization the soils may be divided into two distinct classes, namely, arable and nonarable soils. About 88 percent of the land is arable and is topographically suited to cropping and favorable to the use of labor-saving machinery. The rest is nonarable, as it is either too steep or too rocky to allow the growing of cultivable crops. The fact that areas of virgin grassland with smooth surface relief are now used for grazing does not mean that such land is nonarable. About 17 percent of the area of the county is still used as grazing land, never having been broken, and is still covered by the native grass sod. The soils mapped as nonarable soils are utilized and probably will be utilized for grazing purposes only. At present (1930), about 196,000 acres are utilized for grazing and the rest for cultivated crops. However, the percentage of cultivated land is gradually increasing as the arable soils are broken.

In order of acreage, the chief crops are wheat, corn, oats, kafir, alfalfa, and sweetclover. The acreage devoted to the last two crops is being increased. Wheat, the present dominant crop, is of the hard winter type only. The varieties best adapted to this county include Turkey, Blackhull, and Kanred. The best yielding corn varieties on the upland soils are Pride of Saline, Freed, Hays Golden, and Midland; and on the alluvial soils, Kansas Sunflower, Commercial White, and Pride of Saline. The best adapted variety of oats is Kanota; of alfalfa, Common (local seed); and, among the grain sorghums, Blackhull, Pink kafir, Red kafir, and feterita. Kansas, Orange, Sumac, and Atlas are the favorite varieties of sorgo (sweet sorghum) grown. Although most of these crops are grown throughout the county, regardless of soil, over a period of years there is a direct relationship between crop yields and soil character. A higher return that may be derived from one crop compared with that from some other, is not necessarily the result of unusually favorable soil conditions, but, where conditions other than soil are alike, the soil character expresses itself, not merely in bushels of product, but often in quality as well.

Of the total area in crops, amounting to somewhat more than 400,000 acres, about 380,000 acres are used for the production of wheat, corn, oats, and alfalfa, the alfalfa occupying only about 20,000 acres. Up to 1919 corn was the most important crop in regard to acreage. Since that time the acreage devoted to wheat has steadily increased and that of corn has decreased. The oats acreage has ranged around 50,000 acres since 1899.

Marion County lies in the western part of the region where corn is a dependable crop on the ordinary upland soils, most of which are silt loams or heavier in texture. The increase in the wheat acreage

and a corresponding decrease in that of corn since 1919 may be an expression of this fact. The percentage of sandy loams or other sandy soils, the soils on which corn succeeds best in the region of low or uncertain rainfall, is small in this county. The dominant agricultural soils are silt loams or heavier soils, and on such soils in this region wheat is as a rule the surest crop.

A large proportion of the corn is grown on the alluvial lands, where the presence of ground water at a comparatively slight depth makes corn growing safer than on the uplands. Alfalfa growing is confined mainly to the alluvial lands. The county lies in the alfalfa belt stretching across Nebraska, Kansas, and part of Oklahoma, where the production of this crop on the alluvial lands is very important.

In the following pages, the soils of the county are described in detail, and their agricultural relations are discussed; their distribution and location are shown on the accompanying soil map; and their acreage and proportionate extent are given in table 5.

TABLE 5.—*Acreage and proportionate extent of soils mapped in Marion County, Kans.*

Type of soil	Acres	Per-cent	Type of soil	Acres	Per-cent
Idana silty clay	241,280	39.6	Goessel clay loam, light-colored phase	20,608	3.4
Idana silty clay, reddish-subsoil phase	16,704	2.7	Goessel clay loam	19,200	3.1
Idana silty clay, shallow phase	10,432	1.7	Goessel sandy loam, light-colored phase	1,856	.3
Idana silty clay loam	74,752	12.3	Verdigris silty clay loam	28,928	4.7
Idana silty clay loam, reddish-subsoil phase	2,240	.4	Verdigris silty clay	14,336	2.4
Idana silt loam	3,584	.6	Verdigris fine sandy loam	1,536	.3
Florence silty clay	11,264	1.8	Verdigris loam	2,688	.4
Sogn silty clay	37,120	6.1	Osage clay	2,304	.4
Parsons silty clay loam	10,112	1.7	Reinach silty clay	1,472	.2
Parsons silty clay loam, dark-colored subsoil phase	9,856	1.6	Reinach silty clay loam	1,920	.3
Parsons silty clay	3,008	.5	Idana stony silty clay	41,536	6.8
Goessel silty clay	15,232	2.5	Florence gravelly silty clay	6,464	1.1
Lancaster loam	16,000	2.6	Lancaster loam, steep phase	5,056	.8
Lancaster fine sandy loam	3,200	.5	Sogn silty clay, steep phase	1,536	.3
Lancaster silty clay loam	5,696	.9	Total	609,920	

ARABLE SOILS, OR PLOW LANDS

The arable soils may be subdivided into four groups, based on soil differences that have a marked effect on the crop-producing capacity. The members of each group have, therefore, similar agricultural values, as determined by the type of farming to which they are adapted, the crops that may be grown, the cultural methods employed, fertilization requirements, if any, which are necessary for successful farming, and yields obtained. The several groups are: The Idana group, including the finer textured soils with heavy or moderately heavy subsoils; the Lancaster group, including the sandy soils with friable or moderately friable subsoils; the Parsons group, including the soils with heavy intractable claypan subsoils beneath a surface soil ranging up to about a foot in thickness; and the alluvial soils.

SOILS OF THE IDANA GROUP

The soils of the Idana group are by far the most extensive and agriculturally the most important soils in the county. The general

prosperity of the inhabitants depends largely on the proper utilization and conservation of these soils which include Idana silt loam, Idana silty clay loam, Idana silty clay loam, reddish-subsoil phase, Idana silty clay, Idana silty clay, shallow phase, Idana silty clay, reddish-subsoil phase, Sogn silty clay, and Florence silty clay. These soils occupy a combined area of 620.9 square miles, or 65.2 percent of the total area of the county.

They are well distributed, occupying the broad upland divides and gentle slopes of mild relief. Surface drainage is good, and internal drainage through the clay subsoil ranges from fair to good. These soils are derived from calcareous shales and limestone, their physical condition is generally good, and the surface soils test only slightly acid. With the exception of Sogn silty clay, the surface soils of all members of this group are very dark, showing the presence of a good supply of organic matter. The subsoil, although moderately heavy or heavy, is permeable to air and water, largely because of its granular or crumb structure. Even on older cultivated fields, generally good tilth prevails, except on some of the severely eroded slopes. The fine texture of these soils and the absence of good granulation in the surface soils cause them to puddle when very wet or when plowed before drying after rains. The heavier members break up into large clods when plowed dry. All these soils, with the exception of Sogn silty clay, are well supplied with organic matter. When plowed deep they are highly absorptive of rainfall, and the heavy character of the subsoil makes them retentive of moisture. Their heavy texture makes them warm up more slowly in the spring than the more sandy soils of the Lancaster group. The soils of the Idana group are responsive to good treatment.

All the crops common to the region do well, but the subsoil in most places is too heavy for the best development of fruit-tree roots. Corn and wheat are the dominant crops grown, but wheat is preferred by most farmers, on account of its early maturity. If corn is grown, a droughty period in late summer may seriously affect the yield. A large number of the farmers are grain growers. Approximately 44 percent of these soils is used for wheat, 18 percent for corn, 20 percent for oats, 6 percent for sorghums, 5 percent for alfalfa, and 7 percent for other crops, including pasture.

Idana silty clay.—Idana silty clay is not only the most important soil mapped in Marion County, but it also covers the largest area, occupying a total of 377 square miles. It is one of the heaviest upland soils in the county and is locally called "gumbo." Considerable power is required in plowing, and most farmers plow this land only when it is moist to plow depth. If plowed dry, large clods are turned up, but if harrowed under optimum moisture conditions following a good rain the clods crumble easily.

The 10- or 12-inch topsoil consists of very dark grayish-brown silty clay underlain by a moderately heavy dark-brown clay subsoil to a depth ranging from 24 to 28 inches. This layer, in turn, is underlain by clay, more or less variable in texture but as a whole not so heavy as in the layer above, and the color includes various shades of olive gray. Ordinarily shale occurs below a depth ranging from 4 to 5 feet, but it may occur within 2 feet of the surface near drains or along more pronounced slopes. In places the surface

soil is clay, especially along the belts near small streams. Most of the land within a mile of the source of these streams can be cultivated over the drains because of their gentle slope.

About 85 percent of this soil is under cultivation. The uncultivated areas are most common in the proximity of the nonarable soils. Most of such areas are scattered, irregular in shape, and too small and sloping for most farmers to plow. The main cultivated areas, although gently sloping, are being affected considerably by erosion, but as yet terracing has not been practiced. As a result of continued cultivation, the texture of the surface soil becomes heavier as the lower layers are slowly incorporated in the plow layer. This change will probably have little effect on the kind of crops grown, but cultivation will be more difficult.

The amount of available moisture seems to be the controlling factor in obtaining good yields, especially of corn. Alternation of dry and normal seasons causes very marked fluctuations in yields. Wheat (pl. 1, *A*), the dominant crop, produces a yield ordinarily ranging from 11 to 25 bushels an acre, averaging about 15 bushels; corn from 14 to 40 bushels, averaging about 20 bushels; oats from 18 to 45 bushels, averaging about 25 bushels; kafir from 18 to 40 bushels, averaging about 25 bushels; and alfalfa, from one-half to three-fourths ton a cutting, with the usual four cuttings, or an average of about 2 tons a season.

Idana silty clay, reddish-subsoil phase.—This soil is closely associated with the typical Idana soils, mainly in the central part of the county. It is one of the heaviest upland soils and is locally known as "gumbo."

The topsoil is dark grayish-brown or brown heavy silty clay loam or silty clay, which grades into dark-brown or brown clay at a depth ranging from 10 to 14 inches. The subsoil consists of brown or slightly reddish brown heavy clay which grades into olive-gray clay at a depth ranging from 36 to 50 inches. In cultivated fields a browner tint is recognizable than in similar fields of Idana silty clay. In places rather faintly outlined mounds occur, which are slightly lighter brown, giving the field a somewhat spotted appearance. Such spots are not recognizable in the larger better developed areas.

The surface relief is smooth or gently undulating. Both surface drainage and underdrainage are good. Although erosion has not seriously affected the physical condition of this soil, the older sloping cultivated fields are decidedly heavier in texture than when first broken.

The agricultural value, crops, and crop yields differ very little from those mentioned in the description of Idana silty clay.

In the western part of the county outcroppings of dull-red shales underlain by greenish-gray shales of Permian origin are rather conspicuous, but in most places the strips are too narrow to separate. A few small bodies occurring from 2 to 3 miles southwest of Lehigh are included in mapping. Had these areas been of sufficient extent they probably would have been separated and described as Kirkland silty clay.

Idana silty clay, shallow phase.—This soil is of minor importance and is inextensive. It is closely associated with Idana silty clay and Idana stony silty clay, ordinarily occurring on rather gently undulat-

ing slopes along the borders of the broader ridges or divides occupied by Idana silty clay. It is not good grain land, because it is not easily cultivated, but it is better than the stony shallow soils which are classed exclusively as grazing lands in this report. The best present use for these areas is probably for grazing purposes only. The cultivated areas are not very dependable for intertilled crops, because the underlying limestone and shales retard downward absorption of water, and they are more quickly and more seriously affected by droughts. Good crops are grown only when ideal weather conditions prevail. Wheat, oats, and kafir are best suited to this shallow soil.

The topsoil consists of a 6- or 8-inch layer of dark brownish-gray silty clay. It is underlain by soil material like that of either Sogn or Idana silty clay, but this soil differs from the others in that limestone is present at a depth ranging, in most places, from 1 to 2 feet below the surface. Some limestone protrudes above the surface in spots, but practically all such areas are plowable. The surface relief ranges from undulating to sloping. This soil occurs only on the upper slopes along the edges of the upland divides.

Idana silty clay loam.—Idana silty clay loam ranks second in importance among the arable soils. It is developed on the broad gently undulating divides which are consistently of more gentle relief than the areas of Idana silty clay. The subsoil, although heavy, differs little from that of the silty clay, but it is heavier in spots where the surface is flat or in the vicinity of bodies of Parsons silty clay loam. When moderately dry the topsoil develops an excellent tilth. Even when plowed too wet, very little difficulty is experienced in working the soil and providing a good seed bed. In most places the topsoil is a shade lighter in color than that of Idana silty clay.

About 90 percent of this soil is cultivated. Most of the uncultivated areas occur near drainageways and are utilized either for pasture or hay. The crops grown and the yields obtained differ little, if any, from those produced on Idana silty clay. Wheat is the dominant crop.

Erosion has not seriously affected the physical condition of this soil, but the surface soil is noticeably thinner along the more sloping areas on the edges of the broad divides or near drainageways. In these areas the productiveness and general tilth of the soil probably could be improved and maintained in good condition indefinitely by correct systems of management.

Idana silty clay loam, reddish-subsoil phase.—This is an inextensive soil, and the main bodies occur from 4 to 6 miles northwest of Marion. It resembles Florence silty clay in outward appearance, but the subsoil is not so heavy or dense. Therefore corn and alfalfa succeed well. Tree fruits and berries are more successfully grown than on the heavier Idana soils. As on other soils of this group, wheat dominates, but by a smaller margin. The friability of the subsoil allows a wider range of crops to be grown than on the other Idana soils. The undulating relief insures good surface drainage, and the moderately friable subsoil affords good underdrainage. The medium texture makes cultivation easy, and the loose crumblike structure tends to render the soil absorptive and retentive of moisture. Erosion, however, is a serious menace to the maintenance of productivity and general good tilth of this soil. On some of the

more sloping areas erosion has removed a large proportion of the surface soil, and gullying is noticeable in some fields. Proper terracing might be a great help to make these soils more enduring.

The surface soil consists of a 10- or 12-inch dark-brown or brown silty clay layer, the lower part of which is heavier than the upper. Cultivated fields have a decided brown color, and where severely eroded a slight red tint is noticeable. The subsoil consists of moderately friable brown clay which grades into slightly lighter colored and lighter textured soil at a depth ranging from 24 to 30 inches. In most places, at a depth ranging from about 42 to 56 inches, is a brown clay layer containing some lime concretions.

Idana silt loam.—Idana silt loam is rather inextensive. The principal areas occur on the higher gently undulating divides from 5 to 7 miles northwest of Hillsboro and Durham. This is the lightest textured soil of the Idana group, and it works remarkably well under various moisture conditions. Although an ideal working soil, it is rather susceptible to drifting or blowing.

The 9- to 12-inch topsoil is dark grayish-brown silt loam. It is underlain by a 5-inch transitional layer merging from silty clay loam into silty clay, and this, in turn, is underlain by grayish-brown clay at a depth of 15 or 17 inches. Olive-gray clay is present in most places at a depth ranging from 32 to 36 inches. A few of the more nearly level areas are underlain by a somewhat heavier subsoil, but not a claypan.

About 95 percent of the land is cultivated, chiefly to wheat, corn, oats, and kafir, and yields differ little from those produced on Idana silty clay loam or Idana silty clay. Less erosion occurs on this soil than on other Idana soils, but its effects show in the more sloping areas adjoining small drains.

Florence silty clay.—Florence silty clay lies along the upland slopes adjoining the larger flood plains of the first bottoms, mainly in the central and southeastern parts of the county. Approximately 75 percent of the land is cultivated. In cultivated fields the surface soil is characterized by its brown or slightly reddish brown color. The subsoil varies in color and texture, but in most places it consists of moderately heavy clay, the color of which may range from reddish brown to dull red. Small flinty stone fragments occur sparingly through the soil layers in many places, but in other places they are not noticeable. Shale rock ordinarily occurs at a depth ranging from 4 to 7 feet. It is overlain by soil material several inches thick, splotched with olive green and dull red. Many of these sloping areas have an upper border composed of Idana stony silty clay. The surface soil tests slightly acid and the subsoil neutral.

Wastage caused by erosion is more rapid on this soil than on any other arable soil in the county, but little or no effort has been made to prevent its progress. Gullying is common and is difficult to control. Some of the bodies of this soil, especially those having a slope ranging from 5 to 7 degrees, will probably revert to grazing land, to which use they are probably best suited.

Corn and kafir are very commonly grown, but alfalfa, which is less common, would greatly aid in preventing erosion. Considerable wheat and some oats are grown. Owing to excessive erosion, crop yields are more variable on cultivated fields of this soil than on the Idana soils.

Sogn silty clay.—Sogn silty clay is closely associated with the Idana soils and is fairly evenly distributed but is not very extensive.

This soil is easily distinguished from the Idana soils, in that it has a thinner dark-gray surface soil and a more friable and grayish-yellow subsoil. The supply of organic matter is less abundant, but lime is more abundant. On the older cultivated fields, lime is present at the surface in the more spotted light-colored areas which have been thinned by erosion. The fact that most areas occur on slopes and have an open friable subsoil tends to make them highly erosive, but the productive capacity of this land is not so seriously impaired under erosional activity as that of soils having heavier subsoils. Few of the small strips along drains or ditches are cultivable as are those occurring in the Idana soils, where the drainageways are not so crooked. Approximately 70 percent of the land is cultivated.

Some included bodies in the southwestern part of the county, which are too narrow to show separately, contain thin limestone fragments protruding at certain levels, and the underlying subsoil has a more decided olive-gray cast.

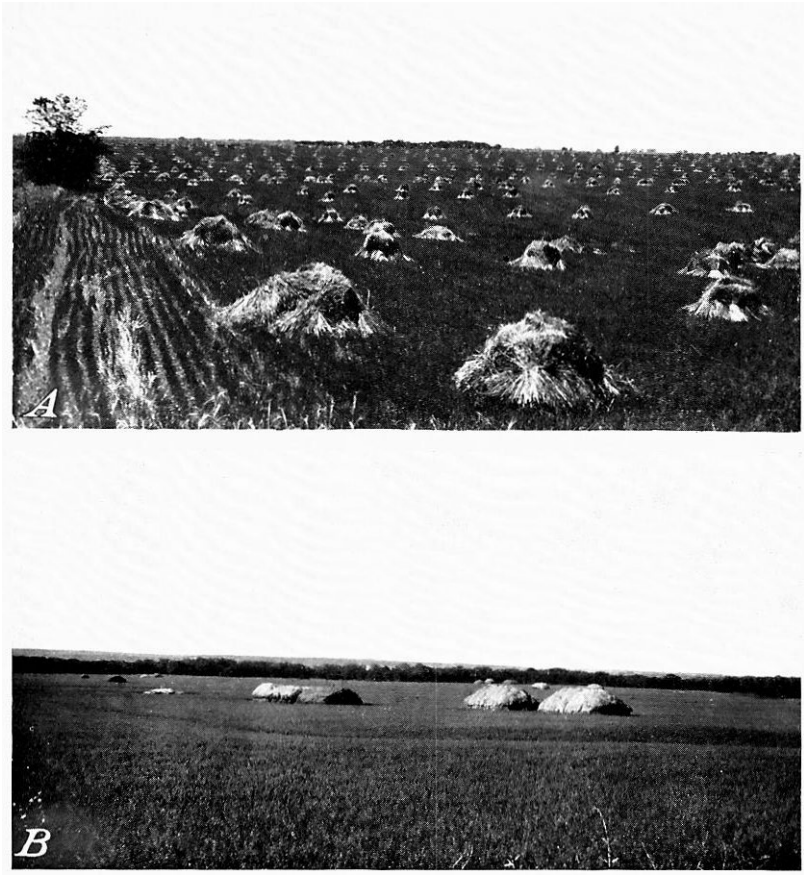
Ordinarily wheat is the most desirable crop for this soil, but some corn, oats, and alfalfa are grown. Corn yields are usually lower than on other soils in this group, probably owing to the lack of organic matter and nitrogen.

SOILS OF THE PARSONS GROUP[5]

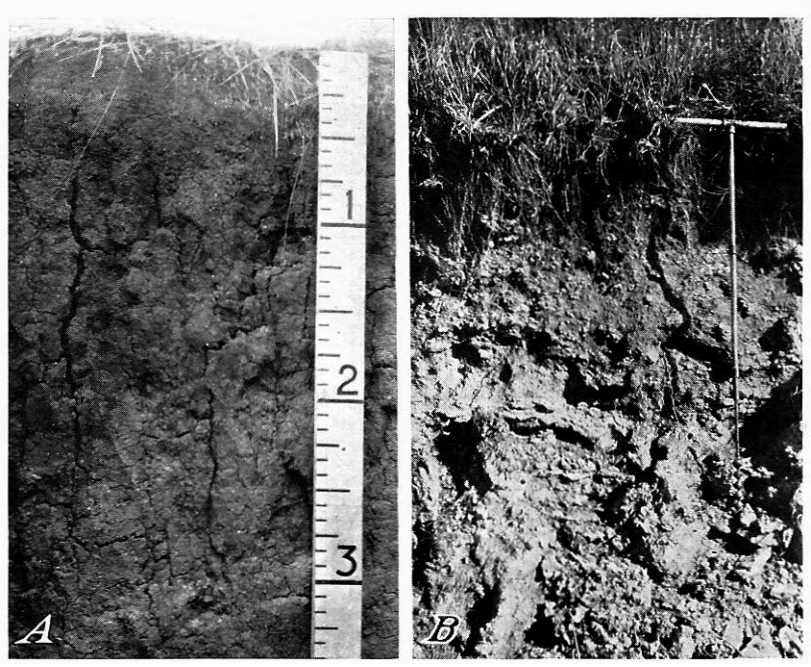
The soils of the Parsons group cover a total area of 59.7 square miles, or 6.3 percent of the county. These soils differ mainly from those of the Idana group in their occurrence in flat areas and in the presence of a subsoil so much heavier than the surface soil as to justify their inclusion as members of a group of claypan soils. The transition from the comparatively light textured surface layer to the heavy claypan is abrupt. Because of the heavy claypan subsoil and the flat relief, surface drainage is imperfect. These soils are medium acid in reaction, being more acid than the members of the Idana group.

Imperfect underdrainage has prevented proper aeration, oxidation, and internal movement of moisture. Optimum moisture conditions endure for short periods only. Plant roots penetrate the stiff impervious subsoil slowly even under moist conditions, but during droughty periods the hard clay prohibits their progress. Furthermore, during droughts, the shrinkage of the heavy claypan causes numerous cracks to form, which range from ½ to 1½ inches in width, are from 6 to 14 inches apart, and range from 3 to 5 feet in depth, depending on the severity of the drought. Many roots are broken and sufficiently exposed to cause them to die. When the soil is too wet, the plants in the lower situations may either die or become permanently stunted. Therefore deep-rooted plants and trees, such as alfalfa, fruit trees, and grapevines do not survive long enough to make them commercially successful. Even corn is uncertain, because of the frequency of droughty periods in late summer, which greatly reduce the yield. The wheat plant, because of its shallow

[5] Since the correlation of the soils in Marion County was made, soils mapped as Parsons soils have been given an independent status as soils of the Woodson series.



A, Twenty-five-bushel-an-acre wheat on gently sloping area of Idana silty clay. *B*, Excellent stand of alfalfa, approaching time for third cutting, on Verdigris silty clay loam, along Cottonwood River.



A, Profile of Idana silty clay, showing numerous cracks in heavy clay subsoil. *B*, Profile of Sogn silty clay. Absence of cracks indicates friable subsoil and numerous concretions and accumulations of lime.

root system and its ripening before midsummer heat and drought occur, is more successfully grown than corn. Timothy, kafir, and other grain sorghums are fairly sucessful because they can withstand adverse weather better than corn.

Wheat yields ordinarily range from 10 to 20 bushels, corn from 14 to 36 bushels, oats from 15 to 35 bushels, and kafir from 15 to 40 bushels. Alfalfa does not endure for so long a time as on the Idana soils, because of the intractability of the subsoil. Sweetclover succeeds in most places and is unexcelled for improving the general tilth and soil productivity.

Approximately 80 percent of the area of these soils is cultivated, and the flatter areas are utilized for either hay or pasture. Prairie grasses ordinarily yield an average of about three-fourths of a ton of hay an acre.

Parsons silty clay loam.—Parsons silty clay loam is associated with Idana stony silty clay, occurring on the narrower ridge divides in the central and southeastern parts of the county.

This soil has a more typically developed claypan than the other soils in the Parsons group, and in plowed fields it is easily distinguished by its grayish-brown or rather light brown surface soil in contrast to the dark grayish-brown surface soil and subsoil of Goessel silty clay and Parsons silty clay loam, dark-colored subsoil phase. The 8- or 10-inch brown or light-brown surface soil is underlain abruptly by an exceedingly stiff brown claypan. Below a depth of 26 inches the clay material is not quite so dense and in most places shows a slight tinge of reddish brown.

Not only is the physical condition of this soil difficult to maintain, but the supply of organic matter and nitrogen is deficient. Wheat and kafir are the chief crops. Wheat yields range from about 10 to 18 bushels an acre, oats from 15 to 35 bushels, and kafir from 16 to 36 bushels. These crops seem better adapted to this soil than the other crops common in this locality. The production of kafir leaves the ground clean, and during dry weather many cracks appear at the surface. Later, rainfall causes erosional movement of the surface soil into cracks of the deep subsoil. The result of this is to make the surface soil over the dense claypan shallow. During the last 40 or 50 years of cultivation, the surface layer in a number of fields has been thinned from 7 or 9 inches thick to about 4 or 5 inches. Some fields which have reached this stage have been abandoned. It is estimated that about 60 percent of the land is cultivated.

Parsons silty clay loam, dark-colored subsoil phase.—Parsons silty clay loam, dark-colored subsoil phase, lies mainly in the eastern and central parts of the county on the nearly flat upland divides and is closely associated with the Idana soils. It differs mainly from the arable Idana soils in its heavier subsoil and its occurrence in very smooth areas. The subsoil is not so consistently heavy as in Parsons silty clay, but it is uniformly heavier than in Idana silty clay, although the somewhat sandy substratum underlying the latter soil is not present. During dry periods, the cultivated areas are not quite so dark as the associated Idana silty clay loam and Idana silty clay but are much darker than cultivated areas of the other

members of the Parsons series. Where the soil occurs on flat surface relief, the subsoil assumes somewhat the character of a claypan, but because of the indefiniteness of the boundaries, these areas have not been separated.

Crops and yields differ little from those produced on Parsons silty clay. Approximately 90 percent of the land is cultivated, and the rest supports a luxuriant growth of wild grasses which are utilized either for grazing or for the production of hay.

Parsons silty clay.—In general, Parsons silty clay occurs on gentle slopes and because of surface erosion has lost much of the surface soil. Before the surface soil was eroded, this was one of the characteristic members of the Parsons series. The surface soil was heavy silt loam, but, owing to erosion, this lighter textured layer is now so very thin that the thickness of the plowed zone is greater than the thickness of the original layer. The plow turns up part of the heavy clay subsoil, converting the surface soil into silty clay rather than silt loam. The claypan subsoil is a little less heavy than the subsoil of Parsons silty clay loam. This soil is difficult to manage in producing cultivated crops, and crop yields are low. The slight depth to the heavy claypan renders the soil subject to extremes of wetness in wet weather and of dryness in dry weather. The growth of a good stand of sweetclover produces a favorable effect by making the heavy clay subsoil less impervious. This soil occurs only in the southeastern part of the county.

Goessel silty clay.—Goessel silty clay is developed on the broad and comparatively high prairie in the southwestern part of the county and occupies 23.8 square miles. Like Idana silty clay this soil is locally known as "gumbo."

The 8- to 11-inch topsoil consists of dark grayish-brown heavy silty clay loam or silty clay, and the subsoil is very stiff heavy grayish-brown clay which has all the appearances of a claypan when dry, but this is not well defined under optimum moisture conditions. At a depth ranging from 24 to 30 inches the material is grayish-brown or dark olive-brown clay, and the degree of stiffness is less pronounced, owing to a more noticeable sprinkling of sand grains which occur sparingly even in the surface layer. The lower subsoil layer gradually becomes lighter in color, less plastic, and more mottled; and sand occurs at a depth ranging from about 9 to 12 feet. The heavy subsoil is not a claypan in the strict sense of the word, since it does not consist of heavy, intractable clay abruptly underlying a lighter textured surface soil. Both surface soil and subsoil are heavy, the latter being somewhat heavier than the former.

About 90 percent of the land is under cultivation, mainly to wheat, and some oats, corn, and kafir are produced. Ordinarily crop yields are slightly higher than on the Parsons soils, owing probably to the prevailingly higher ground-water level, slightly deeper surface layer, and less abrupt gradation into the heavy subsoil. Wheat yields range from about 10 to 20 bushels an acre, oats from 16 to 36 bushels, and corn from 15 to 40 bushels. During extremely droughty years, corn yields sometimes fall below 15 bushels an acre.

SOILS OF THE LANCASTER GROUP

These soils occur mainly in the northwestern part of the county and include 104 square miles, or 10.8 percent of the total area of the county. The soils of the Lancaster series are derived mainly from material residual from sandstone, but the Goessel soils, except the silty clay member of the series, which are included in the Lancaster group, have been developed from a series of fine-grained materials, underlain by sandy material which occur mainly in the southwestern part of the county and seem to be the extreme eastern border of sandy outwash materials occurring as wide-spread deposits in the Great Plains west of Marion County. The soils range from brown to dark brown in color, the sandier members being brown and the heavier members being darker brown. They all occur on slopes and have good surface drainage, and the sandy material of the subsoil assures good internal drainage. Their sandiness makes these soils warm up early in the spring and renders them easy to cultivate, but they are more susceptible to erosion, drifting, and leaching than the other arable soils. Many of the older fields have been greatly thinned by erosion, with the consequent lowering of the content of organic matter and valuable mineral constituents. Erosion is a serious problem confronting the farmers who cultivate this land. Although these soils are very responsive to good treatment or fertilization, their productivity is difficult to maintain.

The fact that these soils are well drained, easily worked, and very permeable to air, water, and plant roots, makes them favorable for corn growing. Corn, therefore, is more commonly grown than on the other arable upland soils. The more sandy soils are really too light in texture for the best growth of grasses or small grains. Various fruits, such as apples, peaches, cherries, grapes, and berries, also do well, because of the friability of the subsoil. Alfalfa and sweetclover succeed in most places.

Lancaster loam.—Lancaster loam lies mainly in the northwestern part of the county, and it is not an extensive soil.

The topsoil, to a depth of about 12 inches, consists of dark-brown or brown loam containing a comparatively high proportion of very fine sand or fine sand particles. After rains, a few hard ferruginous sandstone fragments are noticeable in cultivated fields. The subsoil consists of uniform brown or light-brown friable fine sandy clay. Below a depth of 3 feet numerous small semihard black pellets, embedded in the fine sandy clay, are common. In secs. 29 and 35, T. 17 S., R. 1 E., much of the soil is very fine sandy loam in texture, but such areas are of insufficient extent to justify a separation.

Most of this soil occurs on the higher ridges and slopes. In cultivated fields the soils are not only susceptible to wastage through erosion but to more or less shifting by wind action. Should the spring season be dry the prevailing high winds may cause great injury to growing crops. Approximately 75 percent of the land is cultivated. Most of the soil is medium acid, but legumes succeed without liming. Alfalfa and sweetclover are excellent crops to grow in fields which are more seriously affected either by erosion or drifting.

Lancaster fine sandy loam.—Lancaster fine sandy loam is an inextensive soil occurring on lower slopes than does Lancaster loam

and differing mainly from the latter soil in that the texture of the surface soil is more sandy and the sand grains are generally larger. The surface soil is decidedly brown, and the subsoil consists of brown and, in places, very slightly reddish brown fine sandy clay. Below a depth ranging from 36 to 40 inches, the fine sandy clay is splotched with considerable gray and streaked with rich-brown markings.

This soil is probably more susceptible both to erosion and drifting than Lancaster loam. However, its lower lying position affords some protection from drifting.

Corn is the dominant crop, occupying about 60 percent of the crop-land area. About 90 percent of the total area is cultivated.

Lancaster silty clay loam.—This soil also is of small extent and is associated with the higher ridges of the Idana soils. It occurs mainly in the northwestern part of the county. The soil characteristics are similar to those of Idana silty clay loam.

The 8-inch surface layer consists of brown or dark-brown silty clay loam. It is underlain by a slightly heavier and lighter colored subsurface layer. The subsoil consists of brown clay, but it has a fairly granular structure and is moderately friable at a depth ranging from 36 to 40 inches. The clay subsoil contains some lime concretions, but the brown or slightly reddish brown color gradually changes to rather yellowish gray or olive-gray clay material similar to that underlying the Idana soils.

This soil occurs along the slopes, and erosion has already impaired the agricultural value of most of the cultivated areas. Wheat is the principal crop grown, and the yields probably average less than those obtained on Idana silty clay loam. It is estimated that about 70 percent of the land is cultivated, and the rest is utilized for grazing. All of it, however, is cultivable.

Goessel clay loam, light-colored phase.—This light-colored soil occurs along the lower slopes of the upland adjoining the larger first bottoms in the western part of the county. The Goessel soils have no concentration of clay in the subsoil and therefore differ from the Idana soils in this respect. They resemble the Lancaster soils in surface characteristics but seemingly have been developed from reworked material from the sandy surface deposits of the Great Plains, rather than from old sandstones like those underlying the Lancaster soils.

The topsoil of this light-colored soil consists of a 10-inch surface layer of medium-brown heavy loam or clay loam, in most places underlain by a 5-inch layer of light-brown clay loam or sandy clay. The subsoil is light reddish-brown uniform sandy clay underlain, at a depth ranging from 36 to 40 inches, by a series of layers which differ greatly in color, texture, and thickness. In most places parent shales occur below a depth ranging from 9 to 12 feet, but in places they may occur at greater depths.

This soil is more susceptible to erosion than are most of the Lancaster soils. The surface soil, to plow depth, is variable as regards the amount of clay or sand it may contain, and the color range is from rather dark brown or reddish brown to light brown. Therefore cultivated fields may have a rather spotted or mixed appearance. In places small lighter colored spots may appear. These spots are impregnated with alkali which generally greatly diminishes crop yields.

Such spots become extremely hard in dry weather and are always difficult to cultivate.

Approximately 90 percent of this soil is cultivated. Corn is one of the chief crops grown, and yields in general range from about 15 to 35 bushels an acre. Kafir, being more drought resistant than corn, will probably be grown more extensively in the future. Small grain will probably continue to be grown on varying acreages during different years. Wheat yields commonly range from about 10 to 20 bushels an acre and average about 15 bushels. As this soil is rapidly declining in productiveness, it is apparent that a more general system of soil improvement should be inaugurated, in which terraces and leguminous crops would be used.

Goessel clay loam.—Goessel clay loam occurs along the lower slopes and drains, mainly in the western part of the county. It also covers considerable areas lying adjacent to Goessel silty clay.

This soil differs mainly from Goessel clay loam, light-colored phase, in that the surface soil is consistently darker colored, and the surface relief in most places is less sloping.

In cultivated areas the surface soil consists of dark grayish-brown or dark-brown heavy loam or clay loam, about 10 or 12 inches thick, underlain by brown clay loam. At a depth of about 16 inches the subsoil is light-brown or yellowish-brown sandy clay, and at a depth ranging from 30 to 36 inches the soil material in most places is splotched with light gray, brown, and yellowish brown.

Owing to its mild surface relief, erosion has not greatly thinned the surface layer of this soil. The organic matter and nitrogen content are higher than in other soils of this series. The soil is productive of corn, yields of which range from about 15 to 45 bushels an acre. Wheat yields range from about 10 to 22 bushels. Small fruits, vegetables, and orchard fruits do well, because the soil warms up early in the spring and has a permeable subsoil which allows free root development. It is estimated that about 95 percent of the land is cultivated.

Goessel sandy loam, light-colored phase.—This is a soil of minor importance, occurring in positions similar to those occupied by Goessel clay loam, light-colored phase and, like that soil, closely resembling the Lancaster soils. The sloping surface relief and porous subsoil afford excellent drainage. Some of the areas mapped have a rather uneven billowy appearance, but most of them have comparatively smooth slopes. The more uneven areas are in general more sandy than the other areas and would have been shown as Goessel loamy sand, had they been of sufficient extent. About 75 percent of the land is cultivated, and care must be taken to prevent soil drifting. Corn is ordinarily grown in preference to small grains. Sweetclover does well and is a valuable crop for improving the fertility of the soil.

ALLUVIAL SOILS GROUP

The alluvial soils include 4 soil types of the Verdigris series, 1 of the Osage series, and 2 of the Reinach series. These soils include a total area of 83.1 square miles, or 8.7 percent of the county. They have been developed from periodical overflow deposits. The better drained Verdigris soils have brown surface soils and loose permeable

subsoils, whereas the flatter, less adequately drained Osage soils are very dark colored and have heavy clay subsoils. Because of the high percentage of all the necessary plant nutrients, immunity from erosion, prevailingly high ground-water level, and the considerable protection afforded against high winds, these soils are favorable to the production of many kinds of crops, including corn, alfalfa, small grains, orchard crops, berries, and all kinds of truck crops. Occasionally some of the larger bottoms are overflowed, which offsets, to a certain extent only, the favorable qualities of most of the alluvial soils.

Verdigris silty clay loam.—Verdigris silty clay loam occurs along the first bottoms of both the larger and smaller streams and includes a total area of 45.2 square miles. The more extensive bodies border the larger streams which are marked by a fringe of native trees. The narrower areas, which occur mainly in the northwestern part of the county, are marked by exceptionally crooked and treeless drainageways, rendering the bottoms practically unfit for cultivation. Such areas are in pasture. In cultivated areas, most of the stream meanders are of mild form.

The surface soil of Verdigris silty clay loam consists of an 8- or 10-inch layer of dark-brown silty clay loam which is underlain by similar-colored silty clay. At a depth of 12 or 14 inches, the subsoil consists of moderately friable dark-brown clay which, in most places, extends to a depth ranging from 36 to 40 inches, where it is underlain by light-brown silty clay or clay. Bordering some of the pronounced bends, small strips of loam may occur, but such areas are too small to justify separation on a small-scale map.

In most places corn and alfalfa (pl. 1 *B*) are very important and dependable crops, and considerable wheat is also grown. Corn yields in general range from 25 to 65 bushels an acre, wheat from 15 to 28 bushels, oats from 18 to 36 bushels, and kafir from 20 to 50 bushels. Usually four cuttings of alfalfa are made each year, ranging from one-half to 1 ton at each cutting.

Verdigris silty clay.—Verdigris silty clay is developed mainly along the larger stream bottoms in the southern part of the county. This soil is essentially like Verdigris silty clay loam, except that the texture of the surface soil is heavier, and the characteristic brown clay or silty clay in the lower part of the subsoil occurs at a greater depth in most places. In general, both surface drainage and underdrainage are good. This is a highly productive soil. Its most undesirable feature is the possiblity of damage to crops by an occasional overflow. The heavy texture also causes some difficulty in cultivation, and a desirable tilth is more difficult to maintain than on other Verdigris soils.

The crops grown are mainly corn, alfalfa, wheat, and oats, which return about the same yields as those produced on Verdigris silty clay loam.

Verdigris fine sandy loam.—Most areas of this soil occur along Cottonwood River above and below Durham. Because of the variability in surface relief along the meanderings of streams, the overflow waters have deposited sediments which differ in texture. In the proximity of some of the more pronounced inner bends, the soil occurs at lower levels and has considerable slope, which account

for small included areas of very fine sandy loam, loam, or silt loam. The soil occurring along the outer bends lies at higher levels than that lying from 100 to 200 yards back from the streams. The soil along the inner bends is more susceptible to overflow. The typical surface soil consists of dark-brown fine sandy loam ranging from 10 to 16 inches in thickness, and grading into similar material having a lighter brown color. However, the subsoil is very variable in color and thickness of the layers, because of the different overflow deposits in the past.

Corn is the chief crop grown, and alfalfa does remarkably well. Orchard crops, especially apples and cherries, are well adapted to this soil, especially to the higher lying land. Melons can be produced in large quantities, in fact, many truck crops and vegetables thrive admirably, but the distance from railroads and markets is the main drawback to their production on a commercial scale. Probably 95 percent of the land is cultivated.

Verdigris loam.—Verdigris loam is of small extent. It occurs mainly along Cottonwood River in the northwestern part of the county and in a few places east of Florence. This soil occurs in situations similar to those occupied by Verdigris fine sandy loam.

The bodies east of Florence are of a rather heavy loam texture in the surface soil which contains a high proportion of silt and clay and is underlain by a friable fine sandy clay subsoil. The surface soil in the more typical areas in the northwestern part of the county consists of dark-brown loam, from 8 to 15 inches thick. It is underlain by brown heavy loam, but the lower subsoil layers vary greatly both in color and texture. About 90 percent of the land is cultivated, mainly to corn.

Osage clay.—Osage clay occurs mainly along Cottonwood River between Marion and Durham. About 85 percent of the land is cultivated and is locally known as "gumbo."

The surface soil is very dark gray or grayish-black heavy silty clay or clay, which is extremely hard when dry and tough and intractable when moist. The subsoil consists of heavy clay which grades into dark olive-gray material at a depth ranging from 30 to 40 inches.

The surface relief is flat or nearly so, and the large areas have been provided with drainage ditches to prevent the accumulation of surface water. Underdrainage is inadequate, because of the underlying stiff impervious clay, and tile drainage would improve many areas.

This soil is very difficult to handle. Heavy implements and plenty of power are required. If plowed too wet, the soil is likely to bake and form hard clods, and if plowed too dry large clods are turned up. In most places the soil pulverizes easily when plowed under optimum moisture conditions. During periods of drought the contraction of the clay causes large deep cracks to form.

Wheat is the crop most generally grown. Sufficient lime is present for the successful growth of alfalfa. Some oats and corn are produced, and the yields compare favorably with those obtained on Idana silty clay, but wet seasons are more harmful to crops on this soil than on the Idana soil.

Reinach silty clay.—Reinach silty clay is developed on second-bottom lands, the main areas occurring in the central part of the

county adjoining the first bottoms of the larger streams. Although an inextensive soil, it is practically all cultivated. In profile characteristics it closely resembles Idana silty clay loam, reddish-subsoil phase. The surface soil is brown or rather dark brown silty clay loam ranging from 9 to 12 inches in thickness. The subsoil is brown friable silty clay, becoming lighter in color with increase of depth and lighter in texture below a depth ranging from 24 to 30 inches.

This soil is not surpassed by any upland soil in the county, and practically all of it is cultivated. Although corn and wheat are the principal crops, the land is adapted to many crops. Yields of corn and alfalfa compare favorably with those obtained on the Verdigris soils of the first bottoms. Wheat yields differ only slightly from those produced on Idana silty clay loam.

Reinach silty clay loam.—This soil differs from Reinach silty clay mainly in the lighter texture of its surface soil. Practically all this soil is cultivated, although it is inextensive. Like Reinach silty clay it is adapted to a wide range of crops and is an excellent soil.

NONARABLE OR GRAZING LANDS

The nonarable or grazing lands are separated on the differences of partly weathered parent materials and degree of slope. The abundance of rock and unweathered shales and the sharp surface relief render such soils unfit for cultivation, and they are therefore utilized for grazing purposes only. These soils contain an abundance of lime and other chemical constituents, which produce a luxuriant growth of highly nutritious grasses that are excelled for grazing purposes in few, if any localities in this country. If not overgrazed, the grasses are remarkably drought resistant, and cattle can be fattened during the grazing season without any other ration whatsoever. In order of importance these grasses are [6] big bluestem (*Andropogon furcatus*), little bluestem (*A. scoparius*), side-oats grama (*Bouteloua curtipendula*), Indian grass, (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), dropseed (*Sporobolus cryplandrus*), hairy grama (*Bouteloua hirsuta*), buffalo grass (*Bulbilis dactyloides*), and Texan crabgrass (*Schedonnardus paniculatus*). On the overpastured areas, especially hilltops, buffalo grass and blue grama (*Bouteloua gracilis*) are the more common grasses. Ordinarily these soils are comparatively free of weeds, but on the overgrazed limestone soils ironweed and rockweed are very common. Other common weeds are tumbleweed, ragweed, vervain, stiff-leaved goldenrod, broomweed, aster, and daisy. These soils are susceptible to erosion because of their steep surface relief, and erosion apparently keeps pace with the weathering of the parent limestone, sandstone, or shale of the different soils.

The nonarable soils include Idana stony silty clay, Florence gravelly silty clay, Sogn silty clay, steep phase, and Lancaster loam, steep phase. These soils occupy a total of 85.3 square miles, or 9 percent of the area of the county.

In view of the fact that 25 percent of the land of the county is utilized for grazing purposes and about 12 percent (which includes

[6] This list of plants was submitted by A. E. Aldous, Kansas State College of Agriculture and Applied Science, relating to this county, and does not represent a collection of plants made by the soil surveyor during the progress of the work.

uncultivable areas of arable soils) is nonarable, it is obvious that an area of arable soils equal to the total area of nonarable soils is still utilized for grazing. In grazing value such soils are equal, and most of them are superior, to the nonarable or strictly grazing soils. The arable grazing lands, however, which are gradually decreasing in acreage, are grouped with the arable soils in this report.

Idana stony silty clay.—Idana stony silty clay is extensive, including a total area of 64.9 square miles. It is most extensively developed in the eastern and southeastern parts of the county, occupying the steeper slopes and narrow steep belts of limestone which occur at several distinct levels. Very few bodies of this soil are plowable, and in such places the bodies are too small and steep and the underlying limestone too near the surface to allow cultivation on a commercial basis.

This soil consists of dark grayish-brown or grayish-black heavy silty clay loam or silty clay to a depth ranging from 8 to 12 inches. It is underlain by similar-colored silty clay or clay, which, in turn, is underlain by bluish-gray limestone rock at a depth ranging from 15 to 30 inches. Enough limestone rock protrudes at intervals on the surface to render the land nonarable. The smaller narrow belts north of Marion contain some light-gray or olive-yellow friable silty clay underlying the dark grayish-brown topsoil, at a depth ranging from 6 to 10 inches, but they have sufficient similar-colored limestone material on or below the surface to render the land unfit for cultivation. Several areas southeast of Marion and southeast of Florence contain more or less flinty material or weathered residue of a different limestone formation, but the above-described limestone material predominates.

From 4 to 6 acres are required to pasture a steer from April until the first fall frost. Most of this land is more droughty than Florence gravelly silty clay or Sogn silty clay, steep phase, and overgrazing is more likely to result.

Florence gravelly silty clay.—This is an inextensive soil occurring mainly in the eastern part of the county. It lies at a comparatively higher level than Idana stony silty clay. The surface is strewn with a moderate quantity of small angular chert stones ranging from about an inch to 4 inches in diameter. Stones also occur in the subsoil, but they do not obstruct the penetration of grass roots, hence the land is very dependable for grazing purposes. This soil is very extensive in Chase County and other adjoining counties in the Flint Hill section. Experienced cattlemen maintain that the sod on this soil is not excelled for cattle grazing by that on any other nonarable soil in the country.

The surface relief ranges from sharply rolling to gently undulating. The brows of the hills have a beautifully rounded or beveled appearance, especially where broken by drainageways. The land in a few areas is broken for crops, but the excess of flint makes tillage extremely difficult on such areas.

The surface soil consists of grayish-brown silty clay loam or silty clay, underlain at a depth of about 6 or 8 inches by crumbly silty clay which grades into brown granular silty clay or clay at a depth ranging from 12 to 15 inches. The subsoil consists of brown or slightly reddish brown clay rather than the darker material comprising the

subsoil of Idana stony silty clay. In places there is a suggestion of a claypan.

Lancaster loam, steep phase.—Lancaster loam, steep phase, occurs mainly in a continuous belt about 8 miles long and a mile wide in the northwestern part of the county. The soil is derived from fine-grained sandstone material. The steep and abrupt slopes, which are sharply dissected by small ravines, indicate that this soil is highly erosive. Practically all the drains are marked by deep barren crooked ditches. During periods of drought the sharp slopes, which contain considerable protruding sandstone rock, are more nearly barren than the gently rounded slopes of Florence gravelly silty clay; therefore, this soil is not recognized as a strong grazing soil. Moreover, lime is not present in the subsoil, except in a few places along the lower slopes, where calcareous shales may or may not outcrop.

The topsoil consists of brown loam or fine sandy loam, underlain at a depth of 6 or 8 inches by lighter brown loam or fine sandy loam. The subsoil material varies greatly, owing to the steep relief, but the color is light brown and the texture in most places is fine sand or fine sandy clay above the parent sandstone material.

Sogn silty clay, steep phase.—Sogn silty clay, steep phase, is the least extensive nonarable soil in the county. Most of the bodies lie from 3 to 5 miles northwest of Tampa. The surface relief is almost identical with that of Lancaster loam, steep phase. This soil differs from the other nonarable soils in that the parent material consists of calcareous shales, rather than sandstone, flint, or limestone. It ranks second to Florence gravelly silty clay in grazing value.

The topsoil consists of a 4- to 8-inch layer of dark-gray heavy silty clay intermixed with numerous semihard irregular shaly fragments, most of which contain an abundance of lime. The subsoil, although extremely variable, begins at a depth ranging from 10 to 16 inches and consists of friable light yellowish-gray or olive-gray silty clay loam or silty clay. In most places, the parent shale occurs at a depth ranging from 18 to 30 inches, but it may occur at the surface or below a depth of 30 inches.

AGRICULTURAL METHODS AND MANAGEMENT

Crop yields can be maintained at either a high or a low level, depending on the treatment and management of the soils. Every farmer should strive to so utilize his soil that he may attain the most profitable results and at the same time maintain its maximum productiveness. His success depends largely on his knowledge and skill in supplying the proper treatment, cultural method, or management system on his particular soil or soils and at the same time planting crops to which his land is adapted, so far as the economic situation of the farmer and the region in which he lives allow.

In general, the farmers of Marion County are thrifty and progressive. Improved machinery is in common use, as evidenced by the number of combines, tractors, and other labor-saving devices. Many of the farmers are confused by the revolutionary changes in harvesting machinery, but the more conservative ones are not purchasing machinery unless their acreage warrants and unless they are convinced that the particular machine in question has proved satisfactory

in their locality. A large proportion of the farmers, especially in the western part of the county, use the binder almost exclusively and subsequently stack their small grain. In driving through this section an outsider is immediately impressed by seeing numerous well-constructed wheat stacks. The thrift and progressiveness of these farmers are reflected also in the large number of owner-operated farms.

The methods of growing corn, wheat, oats, and alfalfa are practically the same throughout the county. Corn is usually grown on land following wheat or an old stand of alfalfa. Some farmers on alluvial lands seed their land to corn following corn, sometimes for several years in succession. Ordinarily, in preparing the land for corn the ground is listed in the spring rather than in the fall. On some soils, mainly those with stiff subsoils lying near the surface, this method is not the best to follow. Many soils, especially the more sandy textured ones, if plowed in the fall are rather susceptible to drifting unless listed; and at times an abundance of stubble is necessary to minimize drifting during dry periods. In early May, corn is drilled in the listed furrows which afford considerable protection from high winds. The crop is cultivated at intervals, usually three times. Approximately half the crop is gathered, leaving the stalks in the field to be pastured by livestock during the winter. The rest is cut with a corn binder and either shocked in the field for fodder or cut for silage.

Ordinarily wheat is seeded on land following wheat or oats, but wheat may follow corn, being seeded in the fall after the corn crop has been cut for silage or for shucking. On some farms wheat has succeeded wheat for many years. The best farmers plow their wheatland during summer, immediately after the preceding crop has been harvested. Early plowing is beneficial in many ways—it conserves a larger supply of soil moisture than when the land is plowed later, when numerous cracks have penetrated and facilitated the drying out of the subsoil; and it rids the soil of many insect and weed pests. A good seed bed and plenty of subsoil moisture are highly important factors in producing maximum yields in this section of the State. The depth of plowing is usually from 4 to 8 inches. Later the land is harrowed or disked to conserve the greatest amount of moisture.

The wheat crop is harvested during the latter part of June—June 10 to July 1. The binder is used most extensively, but the combine is being used by many of the larger wheat growers. Some farmers windrow their wheat and, with a pick-up attachment, combine it after it is thoroughly dry. Most of the wheat cut by the binder is threshed from the shock and hauled to the nearest elevator. Stacking the grain provides for an abundance of clean straw which can be fed to livestock or used for bedding. Very few farmers use the header in harvesting wheat.

Alfalfa is grown in nearly all parts of the county. Many important factors are to be considered in the successful production of alfalfa. Should the season be very dry, very little is seeded. This crop is seeded either in the fall or spring, when moisture conditions are most favorable for preparing a firm carefully worked seed bed. A few farmers make a practice of inoculating the surface soil with commercial bacteria or with soil obtained from land on which alfalfa has been grown. A heavy application of barnyard manure, well

worked into the soil, is everywhere advisable, but it should first be applied to cornland rather than to alfalfa land.

Sweetclover is increasing in acreage, and, like alfalfa, is an excellent soil-improvement crop. It is commonly seeded as a nurse crop with oats, from 12 to 15 pounds of scarified seed to the acre being used, and is lightly pastured in the fall. The next season the crop is either pastured, cut for seed, or plowed under as a green-manure crop. The hay is more or less difficult to cure, yet the effect of sweetclover as a soil builder is generally recognized and its value will probably prove more outstanding in the future, as the different soils decline in productiveness. It not only increases the nitrogen and humus content of soils but greatly adds to their physical condition, because the long sturdy roots penetrate stiff subsoils and increase the friability, a feature which is noticeable in the more favorable tilth of the soil. Better underdrainage is thereby made possible, which tends to make a soil condition more favorable for increased yields of succeeding crops. Furthermore, the dense foliage of sweetclover is very effective in the eradication and control of noxious weeds.

Under a well-managed cropping system, approximately one-fourth of the tillable land would be planted to legumes of some sort, in order to maintain a sufficient supply of organic matter. The present acreage is far short of this mark.

It is common practice to seed oats on land following corn. The land is thoroughly disked once or twice, in order to cut up the cornstalks and provide a good seed bed. It is then harrowed, and the oats are either broadcast or drilled—preferably drilled—in the latter part of February or in March, at a rate ranging from 10 to 12 pecks to the acre. The oat crop is fed chiefly to work animals, but some is sold for cash. Occasionally, during droughty periods, oats from some fields are cut green for hay.

Forage crops are grown both for roughage and grain, and they are fed locally. Kafir, the leading forage crop, fits into the feeding ration very satisfactorily, furnishing roughage for the grain that may be fed. The fact that it succeeds on the poorer land where other crops are uncertain, makes it a favored crop, especially in droughty years. It not only provides an abundance of roughage but makes excellent silage, and the grain is excellent for feeding livestock and poultry. The chief drawback, however, is the amount of labor necessary in harvesting the crop. It is first cut with a binder and shocked, or it may be cut for silage at the proper time. The heads may be cut by hand in the field and later threshed, or threshed by cutting the heads from the bundle. Although the grain is slightly inferior to corn in nutritive value, this objection is more than offset by the greater acre yield of both grain and forage, and the greater drought-resistant qualities.

Other forage crops, such as Sudan grass and sorgo, provide an abundance of roughage in the form of fodder, hay, or silage. A much greater tonnage can be obtained of these crops than of corn, and their value when fed as silage is especially appreciated by dairymen. However, only a small proportion of the farmers utilize these crops to the best advantage. A system of diversified farming, in

which provision is made for the utilization of vast quantities of roughage with very little or no grain, seems most practical to farmers in this locality, especially to those who winter a large number of cattle. The practice of dairymen is to provide for considerable roughage and silage and also to produce as much corn and alfalfa as possible, in order to supply their herds throughout the winter.

As no definite or generally recognized system of crop rotation is practiced, crop yields have decreased somewhat below those obtained when the lands were newly broken. Phosphatic fertilizers, such as bone meal and superphosphate, are proving profitable in southeastern Kansas and elsewhere and would probably prove profitable in this locality on the more sandy upland soils, when the proper rates of application and the soil type which will respond most favorably have been definitely determined. Good farming methods, good seed, proved varieties, and precautions against the common crop enemies must be looked after, in order to make the use of commercial fertilizers profitable. Nitrogen and the organic-matter content seem to be decreasing, partly because of erosion and partly through continuous cropping without growing legumes frequently enough to maintain the organic supply. Many farmers are beginning to grow more legumes, especially sweetclover, but very few practice a definite system of crop rotation.

Insect pests, plant diseases, and noxious weeds are becoming more troublesome. Many farmers do nothing to eliminate or keep such enemies under control. Some of the more capable farmers, however, are assuming considerable expense in checking the inroads made on their income by such pests. Of the weeds, the field bindweed (*Convolvulus arvensis*) is doing the most wide-spread harm. At least half of the cultivated land is either thickly or mildly infested, and the infested area is increasing rather than diminishing.

Heretofore plowing, seeding, and cultivation has been straight across the field, and this practice has resulted in facilitating destructive erosion. On slopes of 3-, 4-, or 5-percent gradient, this method has accelerated erosional wastage, until some fields are near the stage of abandonment. Practically all the older sloping fields have surface soils with heavier textures than they had before they lost a large proportion of the topsail which, in most areas, was lighter in texture than the subsoil. Its removal was accompanied by loss of organic matter and valuable plant nutrients. Such fields are therefore less drought resistant, and the soil is very difficult to plow or cultivate, except under optimum moisture conditions. The practice of terracing the sloping fields, in order to conserve both moisture and valuable surface soil, has not yet been adopted, but, in other parts of the State, terracing is proving highly satisfactory. A large part of the tillable land, however, has not as yet suffered greatly from erosion. In view of the fact that erosion is accelerated as the soils become thinner and heavier, there is sufficient reason to warrant the exercise of care in the use of the soil.

SOILS AND THEIR INTERPRETATION

The outstanding characteristic of the soils of Marion County is their dark color. This is only a little less striking, and is universally

applicable to the whole county, than their heavy texture. They are dominantly clay loams or silty clay loams, the area of silt loams and fine sandy loams being very small. The texture is heavier or contains a higher percentage of actual clay than is contained in soils of similar textures in regions where the soils are light in color, especially those of the eastern part of the United States, because in this county the granular structure of the clay materials imparts a loamy character which would not be imparted to such heavy soils in the eastern part of the United States.

Another characteristic of the soils here is their very slight acidity, as they are almost neutral in reaction. This is a striking characteristic, because of their development under a rainfall of about 30 inches. This is only 5 inches less than that in Indiana and Ohio, where the soils are highly acid.

Both the dark color and the very slight acidity of these soils are characteristics common to the soils of the major group of United States soils to which they belong. They are prairie, or humid grassland, soils similar in their dominant features to the soils of Iowa, Illinois, and other parts of the great grassland region lying east of the region of typical black earths of central Kansas. The area of the county lies, however, very near the western boundary of the true prairie soils, which is less than 50 miles west of Marion County.

The soils have developed from unconsolidated silts, clays, and very fine sandy materials accumulated in the eastern and central parts of the county, through the decomposition of calcareous shales and limestones. In the southwestern part, the soil materials consist of deposits of sandy and clay materials of late geological date, laid on the older beds. The true soil materials are the product of the weathering of these materials. It is apparent that this material formerly extended over a much larger part of the county than at present, the occurrence of a small amount of sand over all the county suggesting that it may have covered the whole area but was later removed, before the existing materials were accumulated by decomposition of the limestones and shales. In the northwestern part a small area of soils has developed from material accumulated through the decomposition of somewhat calcareous sandstones.

It is evident from the foregoing that, taking the soils as a whole, their features have been determined to a very great extent by the natural grass vegetation and the climate.

The Idana soils, although dominant, are not true prairie soils, though the lack of normal characteristics is not very great. The subsoil is heavier or contains a higher percentage of clay, when compared with the surface soil, than is characteristic of true prairie soils. The high alkalinity of the deep subsoil, shown in table 6 (p. 34), suggests the presence of a higher percentage of soda than is present in most prairie soils. The nonnormal character of the subsoil may be caused by the presence of a small quantity of soda.

The degree to which the climatic and vegetative agencies have acted on the parent soil material or geologic formation in a given locality depends on the topographic and drainage conditions under which the soils have developed and on the length of time they have

been subjected to undisturbed weathering. In Marion County the valley floors are from 30 to 125 feet below the original plain. As some of the underlying geologic formations consist of thick resistant limestone beds, the surface is highly dissected, many slopes are very steep, and erosion apparently almost keeps pace with weathering of the parent rock. Throughout the county slight or pronounced variations in the character of the parent material, differences in the quantity of water entering the soil, and differences in the rapidity of surface run-off have resulted in the development of several distinct soils.

The dominant soils on the smooth uplands of the county covering the largest area occupied by any one soil series are those of the Idana series. The dominant members of the series, as well as of the county as a whole, are Idana silty clay and Idana silty clay loam.

The following description of a profile of Idana silty clay (pl. 2, *A*) gives a general idea of the more important soil characteristics common over a large part of the county.

0 to 2 inches, dark grayish-brown or grayish-black silty clay which is very finely granular but shows no evidence of lamination. The soil particles are very faintly sprinkled with gray.

2 to 10 inches, very dark grayish-brown granular silty clay, in which the granules range from angular to semirounded in shape and from one-eighth to one-fourth of an inch in diameter. A very slight admixture of minute light gray specks is noticeable. When crushed the soil material is slightly lighter brown.

10 to 15 inches, granular or coarse-granular moderately compact clay, in which the granules are similar to those in the layer above. The material breaks easily when moist but is hard and blocky when dry. The outsides of the granules are very dark gray and when crushed are dark gray.

15 to 26 inches, rather coarse granular clay which, when broken, shows shades of yellowish brown, dark brown, or almost black predominating, and very small rust-brown specks are common. The almost black material represents infiltrations from above. A few small soft ferruginous pellets averaging about one thirty-second of an inch in diameter are embedded throughout this layer.

26 to 43 inches, grayish-yellow or grayish-brown heavy silty clay of indefinite structure. The material breaks into very irregular shaped clods which have a noticeably shiny but irregular outside film. White lime concretions, ranging from one-eighth to as much as 1 inch in diameter, and in most places being 2 or 3 inches apart on a cut or broken surface, are common.

43 to 58 inches, comparatively recently disintegrated highly calcareous olive-gray or olive-green shale material containing numerous pale yellowish-brown or rust-brown inclusions. A slight infiltration of grayish brown is noticeable, especially in the vertical cleavage planes, but in other cleavage planes the thin coating is gray or dark gray. The lime occurs in seams, hard and soft concretions, and in filmlike coatings surrounding some of the smaller shale blocks.

58 to 129 inches, shale similar to that in the layer above except that it is more yellow and is less abundant in lime.

Other Idana soils, such as Idana silt loam and Idana silty clay loam, represent lighter textured soils, and a slightly lighter tinge of dark gray is noticeable in the surface layer. As the degree of slope diminishes and the areas become more nearly level, the degree of compaction in the subsoil increases slightly and the pH values decline slightly.

Many areas associated with the Idana soils and known as the Sogn soils have very pronounced slopes and are derived from highly calcareous shales which are not quite so fine textured. The sloping relief has prevented so thick an accumulation of organic matter, and the subsoils have not been leached of their carbonates to so great a depth. They consist essentially of the underlying calcareous shales and thin-bedded limestone only partly disintegrated (pl. 2, *B*).

In the southwestern part of the county the occurrence of a broad, nearly flat divide has given rise to a dark-colored soil having a semi-claypan subsoil which apparently has been greatly influenced by the flat or very mild surface relief. The following description is characteristic of a profile of Goessel silty clay:

0 to 6 inches, dark grayish-brown silty clay having a fine granular structure and an apparently high content of organic matter. A few quartz sand grains are noticeable.

6 to 10 inches, dark grayish-brown silty clay having a granular structure and containing a slight admixture of minute light-gray particles. The material is medium acid.

10 to 26 inches, dark grayish-brown heavy clay breaking to a coarse-granular or medium-fragmental structure. When dry the material is very hard and does not break easily, but cracks ranging from one-half to 1 inch in diameter, from 6 to 10 inches apart, and from 3 to 5 feet in depth may appear during droughts. A cut surface shows numerous small rust-brown specks, ranging from one one-hundredth to one-fiftieth of an inch in diameter, which blend gradually with the surrounding matrix. This material is medium acid.

26 to 40 inches, grayish-brown or dark olive-brown heavy clay containing sand grains which become more numerous with increase in depth. The material is almost structureless but is blocky when dry. Lime concretions, ranging from about one-tenth to nearly one-half inch in diameter, are fairly abundant. This material is slightly acid.

40 to 50 inches, gray or olive-gray heavy sandy clay which is almost structureless. Lime concretions, ranging from very small to nearly one-half inch in diameter, are fairly abundant.

50 to 68 inches, light olive-gray moderately friable sandy clay containing numerous rust-brown splotches which are rather vague and occupy about 25 percent of the soil mass. Infiltrated dark material and a few Andropogon grass roots penetrate this layer. Lime concretions occur as in the layer above, but they decrease with depth. The material is slightly acid.

68 to 84 inches, light-gray or yellowish-gray moderately friable sandy clay containing some rust-brown or dark-brown stains, a few scattered lime concretions, and some dark infiltrations or thin dark streaks. This material is slightly acid.

84 to 108 inches, olive-gray friable sandy clay mottled and splotched with an abundance of brown or dark-brown stains which seemingly occupy about one-third of the soil mass. Both the sand and moisture content are higher than in the layer above. All angleworm borings, ranging from one-tenth to one-fifth of an inch in diameter, which have penetrated the above layers, terminate in this layer.

108 to 132 inches, brown or yellowish-brown sand containing some clay, grading into almost pure water-saturated sand in the lower part of the layer. The sand grains are well rounded.

In the southeastern part of the county the soils in a number of rather flat and comparatively narrow divides adjoining Idana stony silty clay have brown surface soils and claypan subsoils. Parsons silty clay loam, which is the most important of these soils, has the following profile characteristics under dry conditions:

0 to 8 inches, grayish-brown silty clay loam of fine-granular structure, with rounded or semirounded particles. On crushing, the particles are decidedly lighter brown. The material in this layer is slightly acid.

8 to 10 inches, brownish-gray heavy silty clay loam or silty clay, containing a more conspicuous admixture of very minute specks of light gray than the material above. The soil breaks down to a granular structure, characterized predominantly by angular granules. This material is medium acid.

10 to 26 inches, a brown or dark-brown extremely dense claypan layer. The soil material breaks to a coarse fragmental structure under only a few moisture conditions. When dry it breaks into irregular sharp-edged clods requiring considerable effort to break, owing to the cohesive strength of the exceedingly small clay particles. When dry the contraction of the material in this layer averages at least 10 percent a linear foot, which is evidenced by the presence of vertical cracks ranging from ½ to 1½ inches in breadth and from 6 to 12 inches apart. A cut surface shows numerous small brown or rust-brown specks from one one-hundredth to one-fiftieth of an inch in diameter, which blend gradually with the surrounding matrix. A few small flint or chert fragments are noticeable. The material in this layer is medium acid.

26 to 42 inches, slightly reddish brown dense heavy clay containing numerous semirounded lime concretions ranging from the size of a small pea to that of a hazelnut. Small brown specks are numerous. The structure is rather blocky, but the blocks are feebly expressed. The material in this layer is alkaline.

42 to 60 inches, very slightly reddish brown moderately friable clay showing less uniformity in color. The structure is granular, and the particles are angular. A cut surface shows some black semihard concretions averaging about one twenty-fifth of an inch in diameter, less small brown specks than in the layer above, very few lime concretions, and a rather indistinct mottling of olive gray. In most places limestone rock underlies this soil at a depth ranging from 3 to 10 feet.

In the northwestern part of the county the upland soils are derived from residual sandstone rock and are known as the Lancaster soils. The following description is typical of a profile of Lancaster loam. The other members of the Lancaster series differ mainly in texture of the surface soil or the relative proportion of the different grades of sand.

0 to 12 inches, uniformly dark brown loam containing a comparatively high content of very fine sand. The structure is rather indistinct or imperfectly fine granular.

12 to 16 inches, a brown intermediate layer of slightly lighter color and having a faint fine-granular structure. A few hard ferruginous sandstone fragments are noticeable.

16 to 34 inches, uniform light brown friable imperfectly granular fine sandy clay or clay loam when moist, but the material is rather hard and brittle when dry. Small ferruginous sandstone fragments, ranging from one-eighth to three-eighths of an inch in diameter, are common throughout this and the succeeding layers. In exposed banks a rather prismatic structure prevails. This is the layer of maximum compaction.

35 to 46 inches, light-brown or yellowish-brown clay loam containing numerous black semihard pellets, approximately one-sixteenth inch in diameter, which have black centers.

46 to 72 inches, light-brown or yellowish-brown fine sandy clay somewhat splotched with light gray. Although the material is only slightly acid, no lime is in evidence in this or in any of the above layers. The material in the above layers is medium acid. At intervals this layer contains some unweathered sandstone material.

Table 6 shows the pH values of the more extensive and best developed soils as determined by E. H. Bailey, of the Bureau of Chemistry and Soils. The hydrogen-electrode method was used. The pH units are a convenient expression of the acidic or basic reaction of a soil. A pH value of 7 denotes that the soil is strictly neutral.

Decreasing values of these units from this point indicate increasing acidity or hydrogen-ion concentration, and likewise values greater than pH 7 indicate increasing alkalinity.

TABLE 6.—*pH determinations of soil samples from Marion County, Kans.*

Soil type and sample no.	Depth	pH	Soil type and sample no.	Depth	pH
Idana silty clay:	*Inches*		Goessel silty clay—Continued	*Inches*	
382396	0- 6	5.77	382386	68- 84	7.55
382397	6- 10	5.97	382387	84-108	6.82
382398	11- 28	6.60	382388	108-132	6.82
382399	28- 40	7.73	Lancaster silty clay loam:		
3823100	40- 45	8.12	382323	0- 8	5.82
3823101	45- 60	8.55	382324	8- 12	5.89
3823102	60- 72	8.22	382325	12- 24	6.49
Idana silty clay loam:			382326	24- 40	7.96
382373	0- 10	5.59	382327	40- 48	8.50
382374	10- 15	5.59	382328	48- 60	8.15
382375	15- 36	5.85	Goessel clay loam, light-colored phase:		
382376	36- 48	7.97	382334	0- 10	6.37
382377	48- 72	7.29	382335	10- 15	5.59
382378	72- 84	7.34	382336	15- 30	5.90
382379	84- 90	8.19	382337	30- 33	6.00
Florence silty clay:			382338	33- 40	6.07
382308	0- 5	5.42	382339	40- 43	6.15
382309	5- 8	5.77	382340	43- 46	6.15
382310	8- 24	6.82	382341	46- 51	6.22
382311	24- 46	7.87	382342	51- 60	6.75
382312	46- 56	7.94	Verdigris silty clay loam:		
382313	56- 70	7.72	382365	0- 8	7.33
Parsons silty clay loam, dark-colored subsoil phase:			382366	8- 12	6.70
382352	0- 7	5.39	382367	12- 20	6.47
382353	7- 9	5.53	382368	20- 40	6.82
382354	9- 24	6.85	382369	40- 72	7.09
382355	24- 34	6.92	382370	72- 82	7.25
382356	34- 45	7.85	382371	82- 96	7.09
382357	45- 90	7.52	382372	96-120	7.42
382358	90-100	7.52	Florence gravelly silty clay:		
Goessel silty clay:			382301	0- 6	6.09
382380	0- 6	5.69	382302	6- 12	5.77
382381	6- 10	5.52	382303	12- 17	6.00
382382	10- 26	5.85	382304	17- 33	6.15
382383	26- 40	6.52	382305	33- 44	6.65
382384	40- 50	7.50	382306	44- 52	7.52
382385	50- 68	7.92	382307	52- 60	6.65

SUMMARY

Marion County is in the east-central part of Kansas, about 75 miles north of the Oklahoma State line. It comprises an area of 953 square miles.

The topographic features of about three-fourths of the county are those of a gently undulating plain. The rest of the land ranges from very flat to rather steep. Elevations within the county range from 1,269 to 1,488 feet above sea level. Cottonwood River and its many tributaries form the drainage system.

The population in 1930 was 20,739. Marion, with 1,959 inhabitants, is the county seat and largest town. Adequate transportation facilities are provided by several railroads, highways, and well-maintained county roads.

The climate is temperate, with a mean annual rainfall of 31.31 inches, which, in general, is favorably distributed throughout the year. Severe droughts occur only occasionally.

Nearly half the land is used for grazing livestock. A large part of the grain and hay produced is fed on the farms. Wheat is the principal cash crop.

The soils are placed in two broad groups—the arable soils and the nonarable soils. The Idana soils are by far the most extensive and the most productive soils in the county, and of these, Idana silty clay is the most important.

Commercial fertilizers have not been extensively used. Their use and the growing of legumes, such as alfalfa and sweetclover, to maintain the supply of organic matter in the soils are recommended. Care should be taken to prevent further erosion of the topsoils.

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SOIL MAP
MARION COUNTY
KANSAS

KANSAS AGRICULTURAL EXPERIMENT STATION
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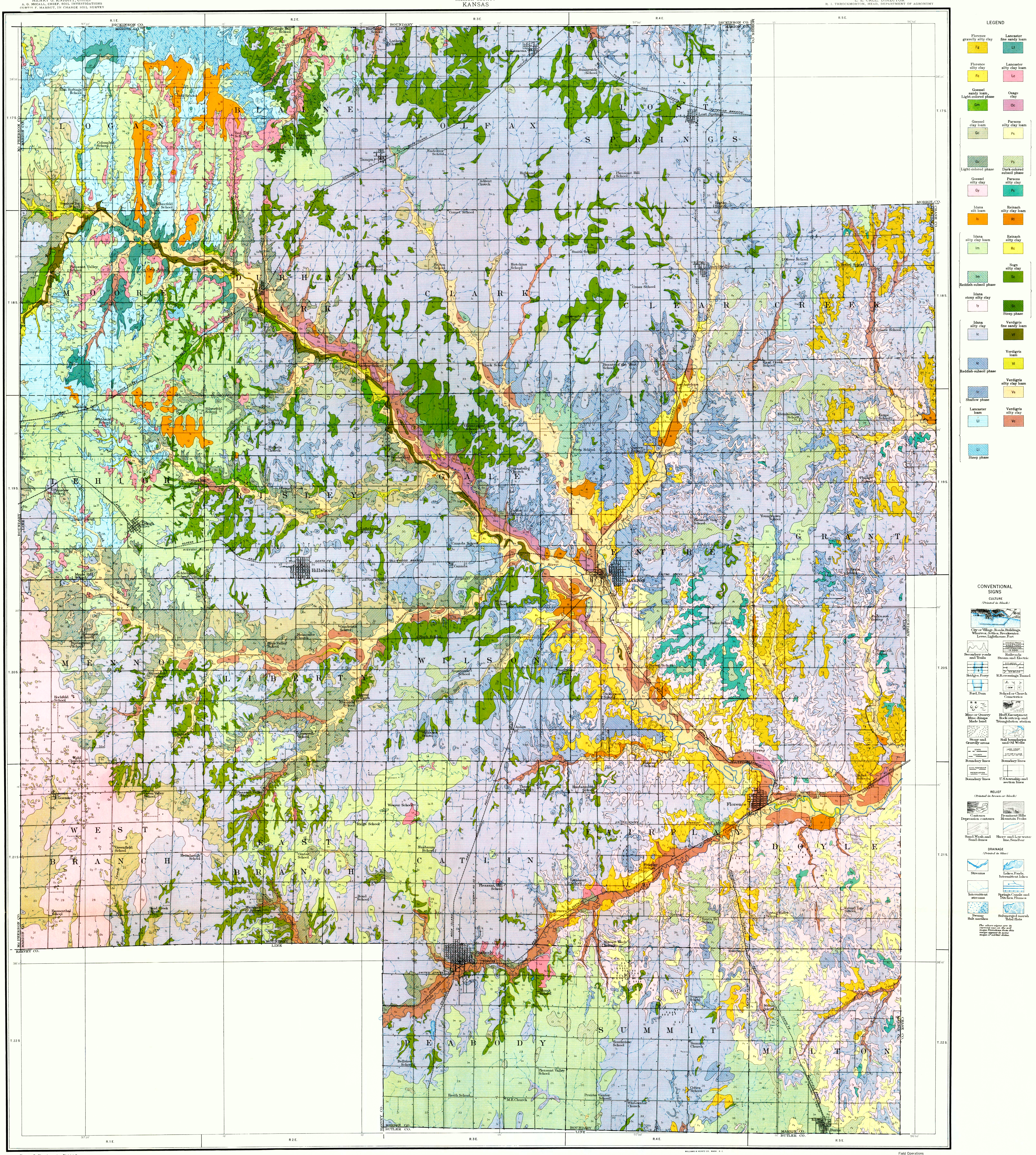

Thomas D. Rice, Inspector, District 3.
Soils surveyed by E. W. Knobel, U. S. Department of Agriculture, in charge, and R. O. Lewis, Kansas Agricultural Experiment Station.

Scale 1 inch - 1 mile

Field Operations
Bureau of Chemistry and Soils
1930